stead of the bards of olden times who were paid by the war-lords to sing their praise and to tell lies in prose and in rhyme, we now have the modern newspaper. But even if some newspapers are glad to have a war on hand which increases their circulation, they can no longer arouse enthusiasm since their war reporters with their deadly kodaks take away all the bombast from their descriptions and only picture stern, prosaic, nasty reality.

Fortunately for us the study of explosives and engines of war has a broader interest. In the same way as the deadliest of poisons have become some of the most valuable therapeutic agents, so have explosives and engines of war found their most valuable applications in the arts of peace. Nitro-cellulose or gun-cotton, one of the most violent explosives, found immediately its applications in surgery, later on in the manufacture of celluloid and also made possible the photographic film. Shall I call your attention to the splendid example of our fellow chemist, Nobel, who with his valuable work on nitro-glycerine, dynamite and similar explosives, has made his discoveries and inventions incomparably more useful in mining and in engineering than in war, and thus created more good than the harm they ever will do in the art of killing. Noble, too, was one of those who did not love war, and he showed it when, after his useful life, he made of his enormous but well-acquired fortune an international bequest for furthering peace and civilization.

Shall I remind you of the time when chemistry did not exist, when the only encouragement which was given to experimental research was dictated by greed, that tried to make gold and thus bribed the skill of the alchemist? And yet what an immense amount of knowledge was thus accumulated! Knowledge which was afterwards utilized for the benefit of mankind.

Let me remind you also, my friends and fellow chemists, that our God-given mission is to utilize our science for the welfare of our whole race; to develop and improve our knowledge, our thoughts, our aspirations, to lead to a better, a higher, a happier race; a race where individual selfishness and conceit shall not count a life by three score and ten, but a race where an individual and a nation are only considered as temporary cells or groups of cells in an everlasting organism that lives through centuries and æons; and which shall keep on improving and improving towards higher and higher standards; unless ignorance, greed and selfishness make it unhappier and unhappier, until finally it finds a fitful and merciful annihilation and perishes and follows the way of the dead races of animals and plants that have only left their traces on past geological periods, and now proclaim to us that they were not apt, not fit, not warranted to perpetuate themselves.

Gentlemen: I now have the pleasure of introducing to you our distinguished fellow chemist, Mr. Hudson Maxim, an American, who by his discoveries, his inventions, by his originality of thought and action, has shown over and over again that he is most eminently qualified to treat the subject of this evening.

L. H. Baekeland

THE WARFARE OF THE FUTURE[1]

How will the battles of the future be fought? In our reasoning we are obliged to proceed from the simple to the complex, from what we know to what we would

[1] Address before the New York Section of the American Chemical Society at the rooms of the Chemists' Club, 108 West 55th Street, on Friday evening, October 9, 1908.

learn. In order to forecast the future, it is necessary to recast the past.

We are to-day marching in the van of achievement with a vast wealth of accomplishment behind us. Still, relatively speaking, we are merely entering at the very threshold of invention.

When primitive man first learned that with a club as a weapon he could vastly reinforce his teeth and fists and claws, he doubtless thought that there remained but little chance for further improvement in weapons of warfare.

The human hand has been forged from the fin of a fish by the human brain. The hand, in its turn, has built upon the microscopic terminal ganglion of the primitive cordworm the giant brain of a Herbert Spencer, infinitesimal piece by piece. Hand and brain have always worked together in a close partnership.

When we compare the course of human invention with the evolutionary processes of nature, we are struck by the parallelism. Everywhere in nature there is a fierce rivalry that stimulates to improved variation to meet the exigencies of necessity. The complex is evolved from the simple and the large has small beginnings. The intelligently selective grows out of blind inertia tending always toward the survival of the fittest. Had we infinite powers of understanding of natural processes, we should then have infinite foresight too and should be able to forecast with unerring accuracy what the future has in store. A sufficient knowledge and observation of nature would have foretold each before its invention, by some parallelism or counterpart in nature, many of the greatest inventions of man.

The screw propeller would have been foreseen in the tail of the fish. The armored saurian of the reptilian age would have given a foreview of the armored knight of the middle ages, destined to hold the mastery awhile, and doomed in turn, just as the old hard-hided antediluvian monsters went down before the agile sharp-toothed carnivora, to fall beneath the supremacy of the light-footed unhelmeted soldier, without shield or cuirass, but whose powers of offense with firearms become his best means of defense too.

The old flint-lock blunderbuss charged with lead and black gun-powder was thought pretty near perfection as a weapon of war. Still, the coat of mail was laid aside slowly and reluctantly; also slowly and reluctantly with the further improvement in firearms did armies break from solid rank formation and disperse over large areas and fight in skirmishing order.

To-day it has become a recognized truism of military science that victory depends upon the concentration of attack upon the most vital points of an enemy's position, while offering to the enemy the minimum of vital exposure. To this end, wisdom has led to the division and dispersion of the men and enginery constituting the units of attack, while still enabling each attacking unit to concentrate upon any desired point of the enemy's position.

The greatest means of defense are efficient means of offense. The greatest protection against receiving heavy blows is to be able to strike heavy blows. A heavy blow upon an enemy is far better than heavy armor on one's self.

Naval warfare too must soon conform to the wisdom of this lesson, and the battleship, the gigantic armored saurian of the sea, is destined to be dominated in the near future by some agile, swift, sharp-toothed carnivora of destruction.

In ancient times, when men fought with clubs and swords and spears, victory depended upon the actual amount of brute force that could be opposed to brute force,

and little depended upon science. With improvements in weapons, warfare becomes more and more a matter of exact science and the military man becomes more and more a civil and mechanical engineer. In the military land operations of the future, science will more than ever be supreme above mere brute force.

Nothing is more apparent than a simple proposition after it has been well learned. To hitch up a steam engine to propeller wheels and drive a boat looks simple enough to us all now, but when Fulton proposed a steamboat voyage up the Hudson, the undertaking appeared about as incredible to most people of the time as a suggested voyage to Mars would now be.

The old wooden hulk was in its day a dare-devil innovation. He was a revolutionist, in the inventive sense, who first fired heavy guns from a ship's deck. The present battleship is only a highly developed *Monitor*, just as the old wooden sailing ship was a highly developed trireme.

It is the same conservative spirit to-day that believes in the battleship as the final arbiter of national supremacy that once believed in the old wooden-sides and adhered to them, opposing all innovations; the same spirit of conservatism that adhered to the Roman galley and placed its faith in the crew of the galley slaves rather than upon the uncertain wind; the same conservatism that made the Carthaginians adhere to their outclassed triremes; and, in inverse order, it is the same spirit of invention combating entrenched conservatism that led the Romans to build their galleys for close-order work, armed with grappling hooks, with which they secured their vessels to the Carthaginian triremes, where the Roman short sword could be brought into play.

When, in the first Punic war, the primitive Roman fleet met and was vanquished by the Carthaginians, the order of battle was the same as it is to-day. The vessels lined up at such a distance apart as would enable the Carthaginians to strike the Romans with their long-range arrows and the stones hurled by their Balearic slingers. When, however, the Romans devised a means whereby they were able to run them down and grapple with them in hand-to-hand conflict, victory was with the Romans.

The next great improvement in naval warfare will be on the lines of ways and means of repeating what the Romans did—ways and means of charging upon and grappling with the mighty war-vessels of an enemy, to sink them with the short sword of high explosives.

There is no one thing so much needed in naval warfare at the present time as a more efficient means of reaching battleships and cruisers with a sufficient quantity of high explosives for their destruction; in other words, there is a more imperative demand for improvements in torpedoes and torpedo-boats than in any other branch of the naval service.

The effective range of the modern high-power gun is now about five miles, and it is the range of the guns that determines the distance between the lines of battle of modern fleets; and the fleet with guns of the longest range has the opposing fleet at its mercy.

A little while ago the Whitehead automobile torpedo was thought to be a valuable adjunct to the armament of the modern battleship, but the range of the guns has now been so increased that such torpedoes become a useless incumbrance, because of the shortness of their range, notwithstanding the fact that their manufacturers have done everything possible to perfect them and to increase their speed and range. Their range is necessarily limited to that

attainable by the charge of compressed air they are capable of carrying.

During the past few years the air pressure has been increased from 1,300 pounds to the square inch to 2,250 pounds to the square inch, and the weight of air from sixty pounds to one hundred and thirty pounds in the eighteen-inch torpedo; and still the maximum range of the eighteen-inch torpedo is only from 3,000 to 3,500 yards, practically about one-third of the range of the high-power guns which determine the distance apart of the lines of battle; and the maximum rate of speed of this torpedo is about thirty-five knots.

In order to carry the air under the enormous pressure, a very strong and very heavy steel air flask is needed; and as the weight of the entire torpedo must not exceed the weight of the water displaced by it, the propelling mechanism has necessarily to be made very light and delicate for the energy it has to transmit.

But what is far more important, the explosive charge also has to be reduced to a minimum, in order to float the heavy air-flask and the weight of air it contains; and this notwithstanding the fact that the quantity of high explosive ought to be greatly increased in order to ensure destruction of the warship struck by it. In the recent war between Russia and Japan the Whitehead torpedo proved a great disappointment.

If the speed of an automobile torpedo could be increased fifty per cent., its accuracy also would be greatly increased, for it would be far less affected by currents, and would be far more likely to strike a moving target, while if its range could be increased one hundred per cent., it would then become an efficient adjunct to the armament of every war vessel, whereas if its range could be increased to five miles—practically three times what its range now is—even though its speed were to remain at thirty-five knots, it would be able to pass over the intervening space separating the lines of battle of opposing fleets.

During the last ten years I have conducted a large number of experiments at a cost of more than $50,000 in the development and demonstration of a system for the propulsion of automobile torpedoes and torpedo-boats by energy derived from the products of combustion of a self-combustive fuel called motorite, consisting of seventy per cent. nitroglycerin and thirty per cent. gun-cotton. The gun-cotton is gelatinated by the nitroglycerin, forming a dense, tough and rubbery material. This material is made into bars about seven inches in diameter and six feet long, for use in torpedoes the size of the eighteen-inch Whitehead torpedo. For the twenty-one-inch torpedo the stick will be both bigger and longer.

The motorite bars are forced into and sealed in steel tubes for use, and these steel tubes containing the motorite are inserted into the torpedo and are surrounded by a water-jacket. The motorite can be ignited and can burn only at and from one end, and water is forced through the water-jacket into the combustion chamber, to be evaporated by the flame blast forcing the water along with it through an atomizing device, whereby it is instantly converted into steam, and the combined steam and products of combustion form the motive fluid.

The water will be taken in from the sea as required, so that it will not be necessary to carry the water-supply on board the torpedo.

One pound of motorite evaporates a little over two pounds of water, so that one pound of motorite produces the equivalent of three pounds of steam, for the products of combustion of the motorite mingle with the steam produced. The steam from the

combustion chamber is conducted to turbines, or other engines or devices for propelling the torpedo through the water. By means of this system of propulsion, the range of the automobile torpedo can easily be doubled, while at the same time its speed can be increased fifty per cent. The heavy air-flask will be done away with and will be replaced by a shell merely strong enough and heavy enough for structural rigidity.

This will enable the carrying of one hundred and sixty pounds of motorite in place of the one hundred and thirty pounds of air now carried, and as each pound of motorite will evaporate two pounds of water, we have available four hundred and eighty pounds of motive fluid; and as steam and products of combustion of motorite are much more efficient as a motive fluid per unit of weight than compressed air, it is safe to assume that we have available four times the energy now available in the eighteen-inch torpedo.

Instead of carrying but two hundred pounds of wet gun-cotton—the present charge—we should be able to carry three hundred pounds of maximite, which is practically twice as powerful per unit of weight as gun-cotton, while its density is fifty per cent. greater than that of gun-cotton, so that we should have a warhead easily three times as powerful as the present war head.

The thing most needed at the present time is a torpedo-boat capable of passing unscathed through the fire of quick-firing guns of a battleship in order to get near enough to reach her with certainty with torpedoes carrying a sufficient quantity of high explosives in the warhead to ensure her destruction when hit.

It is a recognized truism in the field of invention that when there is a very strong demand for anything against which there is no physical law barring its accomplishment, it is sooner or later sure to be accomplished.

There is an enormous demand for a system for reaching and torpedoing battleships with destructive quantities of high explosives. I am strongly of the opinion that the most effectual way of accomplishing the result is to construct a torpedo-boat in the following manner:

Build the hull of the boat somewhat on the lines of the cigar-shaped automobile torpedo—even a perfect counterpart of the torpedo in shape would serve the purpose well; but I would suggest a little greater vertical than longitudinal diameter. In other words, I would build the boat a little more fish-shaped than the torpedo, and I would construct it so that it would be adapted to travel both upon the surface of the water and in a semi-submerged position, or rather, in a nearly submerged position.

I would drive the boat with gasoline engines under normal conditions, and when going into action—that is to say, in making the run of attack—the boat would be in its nearly submerged position and would be driven by the combined power of the gasoline engines and motorite.

The gasoline engines will be provided with a shift gear, something like that employed on automobiles, so that under normal conditions, that is to say, when the boat is propelled along the surface of the water by the gasoline engines alone, the propellers will be driven at a slower speed, and a speed adapted to the speed of the boat thereby secured; but when going into action in a submerged position and traveling at possibly double the speed, the gear will be shifted so that the propellers will travel at a speed commensurate with the higher speed of the torpedo-boat.

The boat will be provided with a top keel or fin a little thicker than a man's

body across the shoulders at the rearward end, being narrowed down forward, and a conning-tower large enough for a man to stand in erect.

The front end of the superstructure will be sharp, and water will be thrown to right and left and will not obscure the forward view of the occupant of the conning-tower. The superstructure will be subdivided into small compartments, filled with cellulose. The partitions between the compartments will be thin sheet metal.

The whole superstructure, except the conning-tower, will be very light and entirely dispensable, and can be shot away without actual damage to the boat itself. The superstructure will be for flotation purposes only, serving to tie the boat to the surface of the water, while the boat itself will be actually submarine. The superstructure will project above the surface of the water about a foot.

The conning-tower will be protected by thin armorplate thick enough to resist the projectiles of small quick-firing guns, and there will be no danger of being hit by guns of a larger caliber.

It will be extremely difficult to hit either the superstructure or the conning-tower, even with small quick-firing guns, for the conning-tower will not be more than two feet above the surface of the water, and will not exceed three feet in diameter, and will be moving forward at the rate of from forty to sixty miles an hour.

Of course, it will require stupendous energy to propel a submarine boat through the water at so high a rate of speed, and there is nothing available known to me except motorite which can supply the required energy. With motorite, however, we have easily all the energy that may be required for any desired rate of speed until the motorite be entirely consumed.

Enough motorite can easily be carried to drive such a submarine boat at a speed of sixty miles an hour for a distance of thirty miles. This will be sufficient to overtake and sink any battleship that might be sighted. Of course, a speed of forty-five miles an hour can be maintained for a much longer time, probably for an hour and a half, with the same quantity of motorite.

The Whitehead torpedo is in reality a sort of submarine torpedo-boat and what is true of it also holds true of the torpedo-boat I propose. Of course, the keel and superstructure in the boat I propose would offer additional resistance, but, on account of the larger size of the boat and its greater length and the enormous quantity of motorite that may be carried, we shall have available more than enough energy to make up for the increased resistance.

The boat will carry, say, a couple of torpedoes in the prow and launch them when getting within close range of a warship. These torpedoes should each carry at least five hundred pounds of high explosive. It would be better if they carried half a ton each in the warhead.

The cost of the torpedo-boat will be slight compared with the destruction it can work. Besides, there need be only two men on board and the lives of but two men will be endangered anyway, and notwithstanding the danger to the men making such an attack, even though the chance of being killed were to be one in two, or even more, there will be no lack of volunteers for the job.

A portion of what I have just said about my system of propulsion of torpedoes and torpedo-boats appeared in the September number of the *Metropolitan Magazine;* but I have several inventions relating to the construction of torpedo-boats that have never yet been published, and one of these is a method for taking on and discharging water with very great rapidity for the submergence and emergence of a semi-sub-

marine torpedo-boat of the type already described, whereby these evolutions could be performed with nearly the facility with which a duck can dive.

Another invention is a torpedo-boat warhead, carried by or forming a part of the bow of the torpedo-boat itself instead of forming a part of an automobile torpedo to be launched by the torpedo-boat.

I have shown how a torpedo-boat may be made so that it may be safely run through the zone of fire of a battleship to launch its torpedoes at close range. I am, however, of the opinion that a far better way, and one which will be adopted in the near future, will be to employ a torpedo-boat which shall itself constitute an enormous torpedo. It will be a species of ram; but instead of depending upon the steel prow for punching a hole in a warship, it will be armed with a ton of high explosive. How about the crew? No, it will not be necessary to sacrifice the crew. The boat will be made, say three hundred feet in length over all, and a hundred feet of the prow portion of the boat will be wholly dispensable and may be blown away without injury to the boat proper, the boat proper being but two hundred feet long.

The warhead of the torpedo-boat will strike the battleship below its armor belt and the blast of the explosion will be inward and upward through the warship, while the reacting blast of the explosive charge will not be very severe upon the occupants of the torpedo-boat. They will be hurled back by an enormous wave of water, but it will not be a quick, sharp destructive blow, dangerous to the occupants of the boat or to the boat itself.

After torpedoing a warship, the torpedo-boat, with its dispensable bow blown off, will still be in perfect trim to retreat and escape. The crew of the battleship at this juncture will be busy with their prayers.

Of course, this torpedo-boat will not supplant the automobile torpedo, for that will be employed in other evolutions; but for the direct run in upon a warship, this form of torpedo-boat with a ton of high explosive in the warhead will be the main arm of naval service, for nothing under heaven could prevent one of these torpedo-boats from selecting any battleship in any fleet and sinking it without a chance in a hundred of being prevented.

In June, 1897, I delivered a lecture before the Royal United Service Institution of Great Britain, wherein I recommended a gun for throwing aerial torpedoes, that is to say, high explosive projectiles of large dimensions, which would be capable of penetrating the deck of any war vessel or of blowing up any war vessel when striking in the water beside it.

I proposed a gun of twenty-four-inch caliber, which need not necessarily be any heavier than the regular twelve-inch service rifle. I showed that this gun would be capable of throwing a projectile weighing a ton and a half and carrying half a ton of high explosive to a distance up to nine miles, according to the elevation. Our war department has now decided to build some guns of greatly increased caliber for the purpose of throwing heavier projectiles carrying much larger bursting charges of high explosive.

Although the initial velocity of these projectiles will not be as great as those now thrown from our high-power twelve-inch guns, still there will be a far less relative energy lost during flight, and they will have proportionately far greater residual energy, so that the range will still not only be maintained but actually increased, although the trajectory will not be quite as flat as at present.

There is also another enormous advantage of this type of gun, and it is that the

initial pressure need not be as great, so that a gun, instead of losing accuracy very rapidly after only the sixtieth round or so, will retain its accuracy up to several hundred rounds. These are some innovations in the right direction.

High explosives are destined to play a far more important part in future warfare than they have played in the past. There are three ways by which high explosives may be brought to bear upon the warships of an enemy for their destruction. One is in the bursting charge of the high explosive armor-piercing projectiles; another is in the submarine torpedo, either in the stationary submarine mine or the self-propelled torpedo, of which latter the Whitehead is the principal type; and the other is in aerial torpedoes, huge projectiles carrying charges of half a ton of high explosives dropped upon and about the warships of an enemy.

During the last decade the principal progress in the use of high explosives has been in the perfecting of bursting charges for armor-piercing projectiles; and to-day we are able to fire high explosive projectiles from powder guns and to penetrate the thickest armor plate, without explosion until the projectile has passed through the plate, to be exploded behind the plate with a proper delay action fuze.

In the land battles of the future, lines of battle will circle sky line and opposing sky line, and over the stupendous arena missiles of death will shriek and roar, while sharpshooters with silent rifles will make ambush in every copse and hedge and highway. Aerial scouts will race across the sky, some in high flight and others hovering low.

In this age of marvels with which the inventor is constantly surprising us, it does not do to sleep too late in the morning, else when we awake we may find ourselves laggards in the abject rear. Achievement now runs on so fast that it often outpaces the adjustment of our senses, and though we pinch ourselves to prove our wakefulness, still the sense of dreaming intrudes on consciousness and harasses conviction.

Many of us in still full life are able to go back far enough in yesterday to view the present through the wide eyes of wonder, while we are so fortified with expectation for the morrow that we look a second time to be assured whether or not that flock of clouds that skirts the sunset may be a fleet of airships climbing up the sky.

The flying machine is no longer confined to the realm of fancy or imagination, but the conquest of the air is already far advanced, and the era of practical utility is near. The wonder of yesterday becomes the commonplace of to-day, and the marvels of to-day will be commonplace to-morrow.

Now that the flying machine has become an actuality, and as all that now remains to be done is to perfect already existing means and apparatus in order to complete the conquest of the air, it is well for us to forecast some of the adjustments that will be necessary to meet the changed conditions when we shall have our aerial navies of commerce and of war.

That the flying machine will find very wide application in future warfare, there can be no doubt. Furthermore, it will be the demand for the flying machine as an engine of war that will give to the industry its greatest stimulus.

Inventors will have to delve in the depths of their genius in order to develop, perfect and bring the flying machine to the very high efficiency necessary to meet the requirements of government specifications.

There is no other incentive to invention so great as that which impels to the development and perfection of implements of war, for the very security of property, country, home and life itself often depends

upon a little lead over an enemy in war inventions.

Some terrible things have been predicted for the flying machine as a war engine. Many a sanguine inventor has claimed that with the advent of his flying machine, battleships, coast fortifications and cities could be utterly destroyed by dropping dynamite from the air. It is comforting to know that no very great loss of life or property would result from dynamite dropped from flying machines, for the reason that dynamite requires confinement to work very wide destruction.

Dynamite must penetrate and explode inside battleships, earthworks and buildings in order to do very great damage. Half a ton of dynamite dropped upon the deck of a battleship might kill a few men, wreck some of the superstructure and dent the deck a bit, but the destruction would not be widespread and the crew below would be uninjured. Dropped on coast fortifications the damage would be negligible.

Half-ton bombs dropped into the streets of a large city, or on top of the great buildings, would shake a few foundations, break a lot of glass and kill a few people. The blast of the dynamite, not being confined, would rebound up into the air in the form of an inverted cone, and the effect in a horizontal plane would be small.

The flying machine will have very great use in war as a scouting craft for the purpose of locating an enemy and inspecting his position; but the enemy will have his aerial pickets out too, and there will be many a tilt in the air between the warring craft. Then it will be that speed will count for much and there will be intense rivalry between the nations in the production of flying machines that will fly fast and fly high, for those able to fly the highest will have a tremendous advantage over their enemies. It will be the high flyers who will win.

I have noticed that great personal bravery is often a concomitant of great intellectuality, and it is proverbial that inventors are the dare-devilest men in the world; and when the flying machine inventor casts the earth loose and rounds the ecliptic with the Pleiades, leaves the earth road and cup races with Jupiter on the cloud way, or goes tobogganing down the sky slide, then the old soldier's oft-spun yarn of how his company mixed their bones with grape and canister, becomes commonplace.

It will be great sport by and by to outrace and override the thunder storm, and there in the bright sunlight look down upon the rolling, seething mass of cloud spitting fire like an angry cat. We shall then seem to have nature at a disadvantage.

In the not distant future, we shall have our automobiles of the air, and in the wars of the future, we shall have our aerial batelships, our cruisers, our torpedo-boats and torpedo-boat destroyers. But they'll be airy, frail and fairy craft indeed compared with the grim steel monsters of the sea.

Although the value of the flying machine in future wars will be mainly as a scouting craft, still its value and importance for that service alone is hard to over-estimate, for the flying machine vedettes will be at once the eyes and ears of the armies of the future; and they will have their use in naval warfare too, for there will be the aerial torpedo scout on the lookout for torpedoes and torpedo-boats, which will signal the approach of danger.

Possibly, too, we shall have our torpedo hawk, taloned with dynamite, which will swoop down out of the sky in swift pursuit of the torpedo or torpedo-boat and blow it up before it reaches its destination. But the torpedo craft will have their sky

guns then and attack will be dangerous work.

The debt we owe the inventor is the difference between all that is ours to enjoy in modern civilized life and the indigence of barbarism. But for the inventor, we should still be denizens of the unbroken forest, clothed in the skins of beasts. Like Antony, the inventor has with his "broad sword quartered the world, and on green Neptune's back with ships made cities." He has hewn highways through the granite hills and web-worked the world with the iron rail.

With his instruments of science the inventor has sounded the deeps of the eternal skies. He has discovered whence Orion came, has felt the pulse of Arcturus, and he knows the fortune and the fate of a million worlds. He has seen them quarried out of chaos far beyond the troubling touch of time; and he views their onward drift toward death in the infinite night and cold of immensity.

He foresees our own bright sun a paling ember on the hearth of time, and he reads our destiny in the scroll of the milky way by light that left its source so long ago that it was already old upon its flight ere Babylon was builded and when the Egyptian pyramids were still unquarried.

In aerial navigation the inventor is obliged to hang his life on the hazard of his mastery of unaccustomed principles, where there are innumerable untried variables—a stunt of the imagination like taking a flight through the fourth dimension.

Aerial naval tactics will include the use of the thunder head to mask manœuvres. When the cloud-hung navies war and ride the storm to battle, then conjecture will attend the fall of slaughtered combatants and wreckage from the sky to know if it be Jove or man that thunders there.

The more highly scientific war enginery becomes the more the game of war will be one that can be played only by the most scientific and enlightened nations.

We, the people of the United States, are to-day dominated by a boundless egoistic obsession concerning our importance and our power compared with the importance and the power of other nations and of other races. This is an outgrowth of our unprecedented prosperity.

Our hitherto isolated geographical position has relieved us of the burden of armaments that other nations have had to bear; but conditions have now changed and the changes are taking place faster than we are waking up to them.

The great increase in the speed of battleships and cruisers, together with their enormously greater size and carrying capacity, has brought the other great war powers nearer home to us and their fleets are now practically at our doors and their vast armies of veterans are almost within gunshot of us.

We have no real army, and though we have a somewhat powerful fleet, England has one far more powerful, and in proportion to our needs for a fleet, ours is the least adequate of that of any country of consequence in the world.

Mr. Reuterdahl told us some ugly things about our navy recently and we were mighty glad when we learned that there was not a word of truth in what he said, and we were made glad again when we learned that the errors of construction which he pointed out would not occur again.

Last winter, President Roosevelt asked for four new battleships and Congress was straightway petitioned by hundreds of prominent turn-the-other-cheekers not to build any battleships. "Shoo, fly, don't bother us. Let us sleep."

We are the greatest industrial people in the world, and we do not want to be burdened with a large standing army. Furthermore, we are fearful that a large standing army would be a menace to our liberties under the guidance of some favorite general or autocratic president.

But we do need *something* of an army, and at the present time we have practically no army at all. The standing army of the United States to-day numbers 75,000 men—mostly engaged as common laborers and servants to the officers. We ought to have at the very least an army of 250,000 men.

The ordnance department asked the last congress for the privilege of keeping important inventions secret and not to make them public by being obliged to advertise for bids for manufacture; but this petition congress has denied.

Water can not rise above its source, and the wisdom of the American congress can not be expected to rise far above the average intelligence of the common people. This is a government of the people, by the people and for the people; and altogether it is the best government in the world for white men to live in. But a government of the few, by the few, and for the few, may make a better war machine.

In Japan, it is only necessary for the Mikado and a few advisers to hold a board meeting and to decide and act upon any measure. Such facility of action as compared with the cumbersone methods of our congress, is like fishing for trout with a light rod and reel compared with fishing with a huge pine tree and making every movement with a derrick.

All the other great powers are arming themselves to the teeth. "But how does this concern us?" asks the American egotist. "We believe that we are the beloved of all the nations. They are all our personal friends."

The present attitude of our American egoism is that we are absolutely without fear. "We have whipped and shall always be able to whip all creation. We are such terrible fighters that guns would only be an encumbrance and burden us in our headlong rush upon the enemy to wring his neck.

"Besides, there is the great American genius which we can draw upon at any time, as we would draw cider from a barrel, and it is only necessary for the conjunction of the American genius with opportunity to make the fantasies of Jules Verne, H. G. Wells and Roy Norton become actualities. The world would have to step in and hold us then or we should do something awful."

Armies can not be made in a day. It takes three years to convert the average citizen into a real soldier. For the first year an army of raw recruits is only a mob.

The modern battalion of veterans is like the flying wedge of a football team—it acts as a unit. How many undisciplined citizens would be required to oppose the onslaught of the flying wedge of Yale? A plain citizen may have the making of a very great pugilist, and still, without training and experience, he could not stand for long in front of a lusty prizefighter.

Arm the American soldier and train him as the soldiers of other nations are armed and trained, and protect him from sickness as the Japanese soldiers are protected, and there is no army in the world that could whip an American army on equal terms.

We do not want to become a great military power and the only way to prevent it is to maintain a navy so powerful as to preclude any possibility of an invasion of a foreign foe—a navy strong enough to withstand any possible coalition against us.

Then we should not need a large standing army. Then we might love and trust our neighbors—but cut their cards.

Should our fleet by any possibility be destroyed, and our country invaded by a foreign foe, it might cost us five billions of dollars and 500,000 lives to dislodge the enemy and to build another fleet such as we would then know we ought to have. Five billions of dollars would build us a navy far larger and more powerful than the combined navies of the world and place us in a position to enforce universal peace.

The peace advocates are so short-sighted that they do not see that if we build but a few guns, we are obliged to slaughter with them, whereas if we were to build guns enough, we could then make war on war and put an end to slaughter.

When we have only a few guns, and not enough to prevent war, then we must use them for killing. If we build guns enough, then we prevent war, and the gun is converted from a death-dealing implement into an instrument for saving life.

HUDSON MAXIM

PUBLIC LECTURES ON MEDICAL SUBJECTS AT THE HARVARD MEDICAL SCHOOL

THE faculty of medicine of Harvard University offers a course of free public lectures, to be given at the medical school, on Saturday evenings at 8, and Sunday afternoons at 4, beginning January 3, and ending April 25, 1909. No tickets are required. Following is a list of the lectures and their subjects, with dates:

January 3—"Fifty Years of Surgery: A Review," Dr. David W. Cheever.

January 9—"Some Things Parents should know about the Teeth of their Children," Dr. Charles A. Brackett.

January 10—"Anatomical Variations," Dr. Thomas Dwight.

January 16—"Auditory Vertigo: Deafness due to Ear Disease," Dr. Clarence J. Blake.

January 17—"Inflammation," Dr. William T. Councilman.

January 23—"Diphtheria and Scarlet Fever," Dr. John H. McCollom.

January 24—"The Circulation of the Blood," Dr. William T. Porter.

January 30—"On the Work for the Relief of the Sick of Various Agencies Other than Medical," Dr. James J. Putnam.

January 31—"Rabies" (illustrated), Dr. Langdon Frothingham.

February 6—"Curvature of the Spine, and School Life," Dr. Edward H. Bradford.

February 7—"Methods of Testing the Acuteness of Vision and Color Perception," Dr. Charles H. Williams.

February 13—"Psychotherapy: Its Use and Abuse," Dr. Richard C. Cabot.

February 14—"Infantile Paralysis and its Treatment," Dr. Edward H. Bradford.

February 20—"The Teeth of Public School Children: How Related to the Children's General Health and Development," Dr. William H. Potter.

February 21—"Psychotherapy: Its Use and Abuse," Dr. Richard C. Cabot.

February 27—"A Study of the Inoculable Tumors of Mice, with Special Reference to Heredity" (illustrated), Dr. Ernest E. Tyzzer.

February 28—"The Hygiene of Pregnancy" (to women only), Dr. Charles M. Green.

March 6—"Glucose," Dr. Lawrence J. Henderson.

March 7—"Pneumonia," Dr. Elliott P. Joslin.

March 13—"Feeding and its Relation to the Infant's Development," Dr. John Lovett Morse.

March 14—"School Life and its Relation to the Child's Development," Dr. Thomas Morgan Rotch.

March 20—"Some Facts as to Disease of the Heart," Dr. Henry Jackson.

March 21—"The Relation of Gastroenteric Conditions to the Development of Early Life," Dr. Charles Hunter Dunn.

March 27—"Dental Hygiene in the School and Home," Dr. Samuel A. Hopkins.

March 28—"State Work in Tuberculosis," Dr. Arthur Tracy Cabot.

April 3—"The Work of the Boston Consumptives' Hospital," Dr. Edwin A. Locke.

April 4—"Psychotherapeutics," Dr. Philip C. Knapp.

April 10—"The Diagnosis and Prognosis of Surgical Affections, with Special Reference to their Early Detection and Treatment," Dr. Maurice H. Richardson.

April 11—"Progress in the Treatment of Cancer," Dr. James G. Mumford.

April 17—"Good and Evil Results of Athletics," Dr. Edward H. Nichols.

April 18—"The Artificial Illumination of Schoolrooms," Dr. Myles Standish.